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Piñon Pine Project Gasifier Start-Up

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Abstract

The IGCC facility built by Sierra Pacific Power Company (SPPCo) at their Tracy Station in Nevada is one of three IGCC facilities being cost-shared by the U.S. Department of Energy (DOE) under their Clean Coal Technology Program. The specific technology to be demonstrated in SPPCo's Round Four Project, known as the Piñon Pine IGCC Project, includes the KRW air blown pressurized fluidized bed gasification process with hot gas cleanup coupled with a combined cycle facility based on a new GE 6FA gas turbine. Construction of the 100 MW IGCC facility began in February 1995 and the first firing of the gas turbine occurred as scheduled on August 15, 1996 with natural gas. Mechanical completion of the gasifier occurred in March 1997. Startup of the gasifier island commenced in December 1997.

This paper will review startup experience for the Transport Desulfurization System through June 1998.

Sierra Pacific Power Company
Tracy Clark Power Station
Piñon Pine Power Project
Sparks, NV

Location: Approximately 18 Miles East of Reno on I-80

July 22, 1998

Project Management Team

Consists of:

Sherry McDonald - Production Manager

Jim Demuth - Project/Startup Manager

Hugh Smith - Commissioning Manager

Pete Cargill - Chief Operating Advisor

OVERVIEW

- Plant General Description
 - Charts
- Expected IGCC Power Plant Performance
- Startup and Operating Status through June 30, 1998
- Transport Desulfurization System
 - AM Session
- Operation of the Hot Gas Filter System
 - PM Session
- Gasifier Restart
 - Resolution of Technical Issues
 - Fines System - BN's
 - Level Probes
 - Fines Combustor

COAL UNLOADING

- 2250 Tons Per Hour
- Designed to receive 84 (100 Ton Coal Cars) per week
- Designed to off load 1 Coal Car every 3 minutes
- Coal Cars dump automatically as the train pulls through at 1/4 mph

COAL DOME

- 250 ft. in diameter
- Holds 16,300 tons of coal
- Approximately 20 day supply when full

STORAGE SILOS

- Coal Silo
 - holds approximately 800 tons
- Limestone Silo
 - Limestone is used as an additive to remove sulfur from the syngas
- Coke Breeze Silo
 - Coke breeze is used for startup only
- Lash Silo
 - (Limestone and ash) is removed from the bottom of the Gasifier and sent to the silo. From the silo, the Lash is sent to a landfill.

Expected IGCC Power Plant Performance

Coal Feed, tons per day	880 (36.5 ton/hr)
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Gas Turbine Power Output, MWe	61
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Steam Turbine Power Output, MWe	46
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Gross Power Output, MWe	107
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• Station Service (Parasitic Load)	07
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Net Power Output	100
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Syngas Flowrate	316,000 lbs/hr
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Pressure	274 psig
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Temperature	1000° F
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Startup and Operating Status

- Limited Experience

Through June 30, 1998

OPERATING HISTORY

JUNE 1 - 30, 1998

- Installed new gearbox and stubshaft on the Filter Fines Screw Feeder
- Gasifier Island Start-up and Syngas Production (Jun 2)
- Gasifier Island shutdown due to failure of both Heat Transfer Fluid Pumps
- Replaced both Heat Transfer Fluid Pumps
- Gasifier Island restart was aborted due to excessive fines carry over through the Hot Gas Filter (Jun 6)
- Replaced the 244 broken ceramic candle filters in the Hot Gas Filter with blanks.
- Replaced impeller in the Recycle Gas Compressor
- Gasifier Island restart (Jun 17)
- Gasifier Island shutdown due to problems with the Filter Fines Lockhopper System
- Gasifier Island restart (Jun 30)
- Gasifier Island shutdown due to problems with the Fines Combustor
- Repaired (9) tube leaks in the Heat Recovery Steam Generator

GASIFIER STARTUP AND SYNGAS PRODUCTION JUNE 2, 1998

- Syngas with a maximum heating value of 135 Btu/scf (LHV basis) was produced over a Gasifier temperature range of 1700° F to 1800° F. This heating value is slightly higher than the design value of 129 Btu/scf.
- Syngas was produced over a period of approximately 7 hours with coke breeze and coal feedstock's. Coal was fed over a period of 5 hours.
- The Gasifier was operated at a pressure of 100 psig with a maximum syngas production rate of 126,000 lb/hr. This is 40% of the design capacity of the plant.
- The Gasifier startup and operation over the above period was smooth.
- Steam produced in the Gasifier Island was exported to the Heat Recovery Steam Generator on the Power Island. The amount of steam produced was equivalent to 5 MW of power.

GASIFIER STARTUP AND SYNGAS PRODUCTION JUNE 17, 1998

- Syngas with a maximum heating value of 128 Btu/scf (LHV basis) was produced over a Gasifier temperature range of 1700° F to 1800° F. This heating value is comparable to the design value of 129 Btu/scf.
- Syngas was produced over a period of approximately 3.5 hours using coal as the feedstock.
- The Gasifier was operated at a pressure of 140 psig with a maximum syngas production rate of 126,400 lb/hr. This is 40% of the design capacity of the plant.
- The Gasifier startup and operation over the above period was smooth.
- Steam produced in the Gasifier Island was exported to the Heat Recovery Steam Generator on the Power Island. The amount of steam produced was equivalent to 4 MW of power.

GASIFIER STARTUP AND SYNGAS PRODUCTION JUNE 30, 1998

- Syngas with a maximum heating value of 119 Btu/scf (LHV basis) was produced over a Gasifier temperature range of 1700° F to 1800° F. This heating value is slightly lower than the design value of 129 Btu/scf.
- Syngas was produced over a period of approximately 6 hours using coal as the feedstock.
- The Gasifier was operated at a pressure of 120 psig with a maximum syngas production rate of 101,000 lb/hr. This is 32% of the design capacity of the plant.
- The Gasifier startup and operation over the above period was smooth.
- Steam produced in the Gasifier Island was exported to the Heat Recovery Steam Generator on the Power Island. The amount of steam produced was equivalent to 7 MW of power.

Transport Desulfurizer & Transport Regenerator Operating History

- Loaded Phillips Z-Sorb into the Desulfurizer (Nov & Dec 1997)
- Z-Sorb Circulation Test
 - Terminated due to excessive sorbent losses (Dec 18, 1997)
- Z-Sorb removed from the Desulfurizer (Jan 1998)
- Sierra entered into discussions with DOE and RTI/Intercat for a replacement sorbent
- RTI/Intercat EX-SO₃ loaded into the Desulfurizer (Jan 1998)
- RTI/Intercat EX-SO₃ circulation tests (Apr 10, 1998)
- To date there has been no cross circulation between the Transport Desulfurizer and the Transport Regenerator

TRANSPORT DESULFURIZER AND SORBENT REGENERATOR

PROCESS DESCRIPTION:

The purpose of the desulfurizer is to remove sulfur compounds from the syngas, before sending it to the gas turbine. The syngas exiting the Gasifier is cooled via two thermal-siphon, steam generating exchangers, from 1800° F to about 1000° F before entering the desulfurizer unit. The gaseous sulfur compounds are removed from the syngas by absorption onto the sorbent, which is circulating in the desulfurizer loop. The sulfur-saturated sorbent is regenerated in the sorbent regenerator unit, and it is returned to the desulfurizer for reuse. Sulfur dioxide gas generated in the sorbent regeneration reaction is sent to the sulfator, where it is reacted with limestone to calcium sulfate.

DESIGN CONDITIONS:

The desulfurizer is designed to reduce the syngas sulfur content from 300 ppm to below 20 ppm, at a syngas flow rate of 316,000 lbs/hr at 1000° F and 274 PSIG, using the Zinc Titanate base sorbent.

OPERATING STATUS:

The Phillips Z-Sorb III Sorbent was loaded into the desulfurizer in early December, 1997. The desulfurizer was placed into service on December 18, 1997, as part of the initial circulation testing of the desulfurizer. After about 10 hours of operation, acceptable circulation was not achieved. This was attributed to the **very high attrition rate of the sorbent**, resulting in excessive carryover to the hot gas filter, and thereby the inability to maintain sufficient inventory in the desulfurizer to sustain circulation.

After evaluating the Z-Sorb test data and further discussions with the DOE, SPPCo decided to pursue an alternate sorbent as developed by RTI/intercat.

On April 10, 1998, RTI/Intercat EX-SO₃ sorbent was circulation tested with good results. Successful circulation of the desulfurizer unit was sustained for more than two hours, after which circulation was stopped in order to focus on the testing of other major components, e.g., the gasifier, hot gas filter, filter fines system, and the fines combustor.

HOT GAS FILTER OPERATING HISTORY

- Hot Gas Filter Performance Evaluation Test (Aug 1997)
- Hot Gas Filter is exposed to particulates from the Desulfurizer during the Z-Sorb Circulation Test (Dec 1997)
- Hot Gas Filter is exposed to "CHAR" particulates from the Gasifier (Mar 1998)
- 126 of the Ceramic Candle Filters were damaged during operation and had to be replaced (Mar 1998)
- 243 of the 244 Ceramic Candle Filters were damaged during operation and had to be replaced (Jun 1998)
- Blanked off all the lower (244) Ceramic Candles (Jun 1998)
- Performed pressure drop tests across the Hot Gas Filter to gather base line data on filter operation with 33% of the candles blanked.

HOT GAS FILTER F501 OPERATING CONDITIONS

- Temperature 1000° F
- Inlet Pressure 260 psig
- Inlet Gas Flow 316,000 lbs/hr
- Inlet Solids Loading 5634 lbs/hr
- Number of Elements 748 Ceramic Candle Filters
- Filtration Area 2132 ft²
- Normal Filter ΔP < 9 psi
- High Filter ΔP > 15 psi
- Shutdown ΔP \geq 20 psi

HOT GAS FILTER (F-501) LEVEL DETECTION/THERMOCOUPLES

Fines level in F-501 is measured by thermocouples in the cone of the filter. There are three thermocouples in the F-501 cone [TE-605, 606, 607]. TE-605 and TE-606 are at the same level and are below TE-607. See attached drawing.

The high level alarm on F-501 is programmed to detect a high level of fines based on the temperature difference between the upper and lower cone thermocouples. As fines fall on a thermocouple, they insulate and cool down the thermocouple. The high level alarm on F-501 comes in if one of the lower cone thermocouples falls to less than 1/2 the value of the upper cone thermocouple.

During plant operation on 6/2/98, a high level built up in F-501 and resulted in breakage of all the filter candles on the bottom row. The high level alarm never came in. See attached chart [check of Algorithm for F-501 Alarm]. The cooling effect on the bottom thermocouples [605, 606] was not enough to bring the alarm in.

Currently, the plant monitors trends of TE-605, 606, 607 to determine if a level is building up in F-501. The trend [see attached chart - Temperatures in F-501] on 6/2/98 shows that at 12:34 the lower TE's [605 and 606] were covered with fines and began to cool off. At around 13:00, the upper TE [607] was covered and began to cool off. The peaks before the TE's were covered are caused by backpulsing the filter. The TE's cool off as a load of fines are dumped on them after each backpulse cycle. The TE's then resume heat up as the fines are removed from the cone.